Advancing **Magnetoseismology** by Ground-based Magnetometer Networks

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ULTIMA kick-off meeting at UCLA
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Field Line Resonance (FLR) Sounding of the Magnetosphere

Successful stations pairs for detecting FLR signals

Turning magnetic field measurements into plasma density measurements
Monitoring Plasmaspheric Density by Ground-based Magnetometers

\[ \log_{10}(\rho_m) \text{ [a.m.u. cm}^{-3}] \]

2007-Oct-25

14.8 UT

Video
Magnetoseismology 1: Field Line Resonance Sounding of the Magnetosphere

• A mature method well tested by previous more localized magnetometer projects (e.g. US McMAC and European PLASMON chains).

• **Knowledge Gap:** (1) Processes that result in the longitudinal structure at the plasmasphere boundary layer during quiet times. (2) The plasma exchange between ionosphere and plasmasphere during storm times.

• **Required Instrumentation (and gap):** (1) A dense 2-D magnetometer network of ~200 stations in North America; There are ~100 stations now; Existing stations still require modest support to continue. (2) Magnetometers on buoys? (Technology not ready)

• **Space Weather Implications:** The plasma mass density obtained through FLR magnetoseismology can be valuable for understanding the cold plasma reservoir, which varies with space weather activity and can affect particle energization.
Magneto-seismology 2: Remote sensing of impulsive processes

Earthquakes and seismic waves

1. **Interior structure of Earth**
2. **Center of Earthquake**

**Sudden impulses**

*The impulse can reveal density distribution in the dayside magnetosphere.*

**Substorm onsets**

*The onset location is important in understanding substorm generation.*
Travel-time Analysis for Substorm Onsets (Magnetotail)

Observations

- Locations of substorm onsets: 18-20 Re in the tail direction
- Substorm onset starts in the magnetotail ~ 100 -- 200 sec before the first auroral brightening.
- Results from several events are consistent with the reconnection model for substorms.

Inversion

- Locations of substorm onsets: 18-20 Re in the tail direction
- Substorm onset starts in the magnetotail ~ 100 -- 200 sec before the first auroral brightening.
- Results from several events are consistent with the reconnection model for substorms.
Magnetoseismology 2: Travel time of impulsive processes from the magnetotail

• Travel-time magnetoseismology has presented initial successes in observing the impulsive processes and the associated environment of the magnetosphere.

• **Knowledge Gaps:** Impulse propagation in the magnetotail – what physics should be included? How the field and plasma conditions affect propagation?

• **Observation Gaps:** Both ground-based and spacecraft magnetic field measurements are relevant. Need model with relevant physics to determine observation gaps. An ISSI team on magnetoseismology has been established to determine where are the most effective locations for new observations.

• **Space Weather Implications:** (1) To locate and time generation of impulsive processes (reconnection, current disruption instabilities, etc.) related to generation of substorms. (2) Results from travel-time magnetoseismology can be ingested to future updates of space weather models to aid forecasting.
## Two Seismic Methods in All Seismologies

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A new ISSI Team on magneto-seismology has just started.